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A longitudinal study of the impact of physical and cognitive decline on the personal network in old age

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ABSTRACT

The effects of cognitive and physical decline on changes in the size and composition of four types of personal networks over a period of six years were investigated in a Dutch sample of 1552 older adults, aged 55–85 years. The effects of age and a decline in cognitive and physical functioning on the probability of changes in all possible network types were investigated. Transitions related to age and to cognitive and physical decline were observed for about one-third of the study sample. Greater age was associated with an increase in the number of family members in the network. Physical decline was associated with a replacement of friends and neighbors by family members only if the network was large. In small networks, no such association occurred. Cognitive decline was associated with a loss of relationships, most likely friends and neighbors, who were not found to be replaced by family members. Physical decline appears to be associated with an increase in the potential number of supporters in the network, whereas cognitive decline is associated with a decrease in the number of potential supporters.

KEY WORDS: aging • longitudinal study • personal network changes

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The 'social convoy' (Kahn & Antonucci, 1981) is a metaphor often used for the changing composition of an individual's personal network. With age, some persons leave the network, but others may join the convoy. Widowhood (Morgan & March, 1992), the death or poor health of network members (Antonucci & Akiyama, 1987), or geographical relocation are typical life events that may result in the loss of members from the network. However, losing members does not necessarily lead to a breakdown of the network, as lost relationships are often replaced by new relationships. In the Longitudinal Aging Study Amsterdam, Van Tilburg (1998) found that the network size of about 70% of the adults aged between 60 and 85 years was either stable or increased over a period of four years.

One of the key functions of the personal network is the provision of social support, through which the network contributes to the well-being of aging individuals (Mor Barak & Miller, 1991). However, not all types of network relationships provide support. It has often been observed that kin, especially, provide support (Litwak, 1985), friends tend to provide emotional support (Broese van Groenou & Van Tilburg, 1997), and, because of their proximity, neighbors provide short-term help. The support received from a network is thus a function of not only the size of the network, but also the type of relationships involved. Changes in the size and composition of the network may have important consequences for the total amount of support received from the network.

Changes in network composition can be explained in terms of the proactive behavior of aging individuals (Carstensen, 1992) and age-associated changes, such as diminishing physical capacity (Stoller & Pugliesi, 1988). It has been noted that, along with the amount of support received from the network, there tends to be an increase in the number of helpers in the networks of older adults in poor health. This has been interpreted as a mobilization of helpers (Van Tilburg, 1998). Another type of age-associated change in health that may affect the composition of the network is a change in cognitive capacity, which is often observed with aging (e.g., Cullum et al., 2000). However, it is still largely unclear whether a decline in cognitive functioning leads to a network change.

The presumed mobilization of helpers suggests that individuals who are confronted with the loss of cognitive or physical capacities adapt their network by replacing members. As family relationships in general provide the majority of informal support for older adults, the network may increasingly consist of family members, such as the spouse, children, and siblings – a supposition that is supported by three theoretical arguments. First, according to the socio-emotional selectivity theory (SST), aging people increasingly select relationships that provide more emotional support, and fewer relationships that provide only information or that fulfill affiliation needs (Carstensen, 1992). As a consequence, the personal networks of older individuals increasingly consist of their children and siblings, and, according to Carstensen, friends, because they are also likely to give emotional support.

Second, the theory of selective optimization with compensation (SOC)

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suggests that a decline in cognitive or physical capacity forces people to select and optimize relationships from which the highest amount of social support can be expected, instead of trying to maintain all their relationships (Baltes & Carstensen, 1996). As close relatives are more likely to provide long-term instrumental support than nonrelatives, an increase in the proportion of close relatives in the network is to be expected when people suffer from cognitive and physical decline.

Third, based upon exchange theory (Gouldner, 1960), changes in personal networks can be explained in terms of reciprocity, which implies that people prefer relationships in which the exchange of support is balanced. When their physical or cognitive capacities are diminished, people need support; however, this decline makes it difficult for them to reciprocate (Dowd, 1984), and the balance of receiving and giving support will be affected, which may, in turn, lead to an end of the relationship. However, Lee, Netzer, and Coward (1995) argue that kinship relationships are characterized by life-course reciprocity, in which exchanges balance out over the lifetime. Kinship relationships are therefore less likely to end when the balance of support becomes distorted.

These theories vary in the degree to which they ascribe changes in network composition to age or age-associated factors, such as cognitive and physical decline. The study reported here investigated the extent to which changes in the size and composition of a network occur and, controlling for the effect of age, whether physical and cognitive decline increases the likelihood of network change. In addition to changes associated with the passage of time alone, controlling for age makes it possible to determine the effects of physical and cognitive decline on the personal network.

The data were derived from a large population-based sample of adults aged between 55 and 85 years at baseline and followed over six years. We hypothesized that, apart from age, a decline in cognitive and physical capacities will result in neighbors being replaced with family members and friends in the individual's social network. Consequently, the proportion of family and friends in the network will increase (Hypothesis 1). Meanwhile, owing to the mobilization of helpers, we did not expect cognitive and physical decline to result in a reduction in the size of the network (Hypothesis 2).

Method

Sample

Data were drawn from the Longitudinal Aging Study Amsterdam (LASA), which is an ongoing longitudinal, multidisciplinary research project focusing on autonomy and well-being in the aging population (Deeg, Knipscheer, & Van Tilburg, 1993). The LASA sample is stratified by birth year and sex, and there is an over-sampling of older and male participants. Initially recruited for the study 'Living Arrangements and Social Networks of Older Adults' (LSN) (Knipscheer, de Jong Gierveld, Van Tilburg, & Dykstra, 1995), the sample of 3805 individuals was drawn from the population registers of 11 municipalities in three culturally distinct geographical areas in the Netherlands. In the first

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LASA cycle (T1, 1992/1993), 3107 persons aged 55–85 years participated; 698 of the original LSN respondents were not included because of death (126, 18%) or inability to participate because of severe physical and/or mental health problems (134, 19%). An additional 394 (56%) refused to be re-interviewed and 44 (6%) could not be contacted. Data from the second cycle (T2) were not included in this study. The third LASA cycle (T3) was conducted in 1998/1999. Total attrition between T1 and T3 was 1031 individuals, due to mortality (761, 74%), refusal (160, 13%), frailty (81, 8%), and inability to be contacted (29, 3%). The exclusion of respondents with missing data on any of the study variables further reduced the sample to 1552 respondents (50% of the T1 sample).

Attrition was associated with lower cognitive performance (i.e., 2 points lower on the 30-point Mini Mental State Examination [MMSE] scale, Folstein, Folstein, & McHugh, 1975), older age (respondents were six years older), number of chronic diseases (0.4 more chronic diseases), smaller network (2.2 persons smaller), and a higher proportion of family members in the network (all significant at $p < .05$). However, there was still a large proportion (48%) of respondents with two or more chronic diseases or with a low score on the MMSE (3% with a score below 20 and 15% between 20 and 25), suggesting that there was sufficient heterogeneity of physical and cognitive functioning in the study sample. Furthermore, the types of networks among respondents who were lost to follow-up were no different from the networks of those who remained in the study. A latent class analysis on the respondents lost to follow-up revealed that 32% of the respondents had a Type I network, 18% a Type II, 22% a Type III, and 28% a Type IV network at T1. For respondents not lost to follow-up, the distribution of network types at T1 was 30, 18, 22, and 31%, respectively (see *Procedure* for a description of the network types; see Table 3 for the distribution of network types). This suggested that attrition would not have a significant impact on the generalizability of the study results.

At both T1 and T3, data on the LASA participants were collected by means of two face-to-face interviews and one self-administered questionnaire. The same instruments were used both times.

Measurements

In order to obtain adequate information on the networks of older adults, we looked for detailed information about their relationships, with network members identified by name. The objective was to identify a network that reflected the socially active relationships of the older adult in the core, as well as the periphery, of the network. Several criteria were used in selecting who was to be included in the network. First, the composition of the network had to be as varied as possible, meaning that all types of relationships had the same chance of being included. This led to a domain-specific approach in identifying the network, using seven formal types of relationships (see later).

A second objective was to include all the network members with whom the respondent had regular contact and with whom the contact was important. This guaranteed that socially active and important relationships would be identified. Network members were identified in seven domains: household members (including the spouse, if there was one), children and their partners, other relatives, neighbors, colleagues from work (including volunteer work) or school, members of organizations (e.g., social clubs, church, political parties), and others (i.e., friends and acquaintances). Respondents were asked the following question: 'Name the people (e.g., in your neighborhood) you have frequent contact with and who are also important to you.' Only people above

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the age of 18 could be nominated. A limit of 80 was set on the number of persons, but no one reached this limit. Information on sex, frequency of contact, and type of relationship (categorized as relative, neighbor, friend, and other nonrelative) was gathered on all the network members identified. For a subset of network members (the 10 with the highest frequency of contact), a question was asked about the time it took them to travel to reach the respondent (Van Tilburg, 1995).

Physical functioning was assessed using a physical performance index (Kriegsman, Deeg, Van Eijk, & Penninx, 1997), based on the ability to perform three activities: going up and down a staircase with 15 steps without having to stop, using own or public transportation, and cutting one's own toenails. Respondents are asked to indicate whether they have difficulty performing the activity, whether they need help, or whether they are able to perform the activity at all. Responses can range from 0 (*not able to carry out the activity*) to 3 (*no difficulties*), and the sum of the three items, ranging from 0 to 9, serves as an index of physical functioning, with higher scores indicating better physical functioning. This index provides a reliable measure of physical functioning (Cronbach's $\alpha = .78$ at T1 and T3).

Cognitive functioning was assessed with the MMSE (Folstein et al., 1975), which involves recall, orientation, registration, attention, language, and construction. Scores range from 0 to 30, with higher scores indicating better cognitive performance. At T1, Cronbach's $\alpha = .69$, and at T3 $\alpha = .61$, which is low for a 23-item scale; however, it is comparable with the α found in other population-based surveys. Moreover, Tombaugh and McIntyre (1992) have determined that the severity of cognitive impairment and cognitive change can be satisfactorily assessed with the MMSE.

Procedure

We used log-linear modeling with latent variables. This type of modeling, also referred to as Latent Transitional Modeling (Collins & Wugalter, 1992; Muthén & Muthén, 2000), enabled us to make simultaneous estimations of the network type that people have (based on differences in size and composition) and the likelihood of an individual making a change from one type to another, conditional on age and on physical and cognitive decline. This method combines latent class analysis with log-linear path analysis and is comparable to structural equations modeling (Collins & Wugalter, 1992; Hagenaars, 1993) when all the variables, *including the latent variables*, are categorical. The model was estimated using LEM (Vermunt, 1997a).

There are two important reasons for using this type of modeling in preference to the better-known methods of turnover tables or a series of regression analyses. Turnover tables based on observed data showing transitions between discrete states may lead to an overestimation of change due to measurement error. Even small amounts of measurement error can attenuate the associations between the variables and lead to spurious observed transitions and overestimation of the amount of gross changes (Bassi, Hagenaars, Croon, & Vermunt, 2000). The log-linear model with categorical latent variables used in our analysis corrects for this. Furthermore, regression analysis or the use of a sum score 'does not fully utilize all available information such as the potential correlation among various indicators. Also, combining scores inherently assumes that indicators are exchangeable which can cause difficulties particularly when indicators have opposite effects' (Reboussin, Reboussin, Liang, & Anthony, 1998, p. 458).

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Log-linear analysis with categorical latent variables

To facilitate interpretation of the results, we will explain the basic aspects of the model. For a more detailed explanation of log-linear analysis with categorical latent variables, the reader is referred to Hagenaars (1993); for a more detailed explanation of latent class analysis, see McCutcheon (1987). A more detailed explanation of logit modeling can be found in DeMaris (1992).

The log-linear model with latent variables involves a *measurement model* and a *structural model*. The *measurement model* is a latent class analysis, used here to specify types of networks. Two types of parameters are essential in the measurement model: latent class probabilities and conditional probabilities. The latent class probabilities reflect the proportion of individuals in our total sample who had a specific network type. The conditional probabilities provide information on how to characterize the specific network types (McCutcheon, 1987). To illustrate how conditional probabilities should be interpreted, see Table 2. We looked at four kinds of networks, and, for each type, a different set of conditional probabilities was estimated.

The majority of the respondents in Type I networks (73%) had a large network (> 14 members). Some (27%) had a medium-sized network, but no one had a small network. Furthermore, people in Type I networks had fewer than the mean proportion of relationships involving relatives (the mean was 60%), 74% had at least one friend, and most (62%) had more then the average proportion of neighbors (the mean was 11%). Type I is thus characterized by a large network, consisting of fewer relationships with relatives than average and more friends and neighbors than average.

The *structural model* is a set of logit equations specifying relationships between the network types and age, physical status, and cognitive decline. More specifically, the probability of making a change from one type of network to another is estimated. LEM also estimates conditional probabilities, meaning that the probability of changing from one network type to another is estimated separately for respondents in combinations of different conditions (i.e., age category and the existence of cognitive or physical decline). Probability (p) is judged to deviate significantly from zero when the probability divided by its standard error is larger than 1.96 (DeMaris, 1992).

All types of probabilities are estimated simultaneously, applying the EM algorithm (Dempster, Laird, & Rubin, 1977). To find a unique solution, the number of parameters to be estimated should not exceed the number of information units (i.e., the number of cells in the observed contingency table minus one). The number of parameters to be estimated is further restricted in the sense that too many categories in the variables make it difficult to interpret the results. For this reason, we have dichotomized all the variables used as network indicators around the mean proportion (except for network size, which has three categories). The three categories of network size were based on two considerations. First, we split network size around the median value into a group with more than 14 members and a group with 14 or fewer members. Next, we split the group with 14 or fewer members into two groups to further distinguish between small networks (fewer than 6 members) and medium-sized networks (between 6 and 14 members) (Broese van Groenou & Van Tilburg, 1996).

With respect to friends, 53% of the respondents did not identify any; they were separated from those who identified one or more friends. The proportion of relationships with relatives was calculated as the number of kin relationships divided by the total network size. The same was done for the proportion of

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neighbors. Age was categorized into two groups: young-old (between 55 and 70 years at T1) and older-old adults (between 71 and 85 at T1). Scores for cognitive and physical functioning were compared for T1 and T3 and categorized as decline and no decline. Changes between T1 and T3 were calculated using the Edwards-Nunnally difference score, which takes into account the unreliability of the measurement as well as regression to the mean (Speer & Greenbaum, 1995). Respondents with missing data for any of the variables were excluded from the analysis.

In accordance with Collins and Wugalter (1992), Reboussin et al. (1998), and Vermunt (1997b), the 'factor loading' of the indicators at T3 was set equal to the loading at T1 (i.e., time-homogeneous). It is common in longitudinal latent-variable models to constrain the parameters to be time-invariant; the most meaningful models are those that constrain the factor loading to be equal across occasions (Collins & Wugalter, 1992).

Estimation of the parameters was carried out in a stepwise procedure. The first step was to decide on the number of different networks to be identified. Increasing the number of latent classes usually improves the fit of the model; however, having too many latent classes increases the risk of very sparse tables, which can lead to poor parameter estimation and interpretation. Goodman (1974) suggests that, in estimating the number of latent classes (i.e., the number of network types in our study), an upper limit has to be placed on the number of classes and then the corresponding class sizes are estimated. If any estimated class size is not significantly larger than zero, the number of classes can be reduced until all classes differ from zero. The theoretically based upper limit used in our study comes from Wenger (1992), who distinguished five different types of support networks, which provided a reasonable starting point for our analysis.

The second step was to include the structural part of the model, in which the relationships between the latent variables and the external variables (age, physical decline, and cognitive decline) were specified. We started the estimation procedure with the full saturated model, including all possible (higher order) interaction effects, and excluding all nonsignificant effects one by one until a just identified model remained.

Indicators of types of networks

Wenger's (1992) network-support typology served as a model for the indicators of network types in our study. However, the traveling time used by Wenger did not discriminate among our network types (i.e., traveling time appeared to be equally loaded on all latent categories). Consequently, we removed traveling time from the model, which resulted in a selection of four indicators of personal network: size of network and proportion of kin relations, friends, and neighbors. The proportion of other nonrelatives was omitted because it was linearly dependent on the other three proportions.

Results

About two-thirds of the sample were aged between 55 and 70 years at T1. Cognitive decline alone was observed for 319 (21%) of the respondents between T1 and T3, and physical decline alone for 304 (20%). Both cognitive and physical decline were observed in 101 (7%) of the respondents (see Table 1). On average, the total size of the network did not change; however,

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TABLE 1
Characteristics of the sample at T_1 and T_3 (N = 1552)

	T1				T3			
	n	*M*	*SD*	%	*n*	*M*	*SD*	%
Age at T1 (years)								
Between 50 and 70	975			63				
Between 71 and 85	577			37				
MMSE (range 1–30)		27.75	1.93			27.17	2.82	
Physical performance (range 0–9)		8.62	1.04			8.17	1.61	
Age by physical and cognitive functioning								
55–70, no physical decline, no cognitive decline					775			50
55–70, no physical decline, cognitive decline					104			7
55–70, physical decline, no cognitive decline					77			5
55–70, physical decline, cognitive decline					19			1
71–85, no physical decline, no cognitive decline					255			16
71–85, no physical decline, cognitive decline					114			7
71–85, physical decline, no cognitive decline					126			8
71–85, physical decline, cognitive decline					82			5
Network size (range 1–75)		14.8	8.5			14.8	9.0	
1–5 members	202			13	244			16
6–14 members	655			42	646			41
> 14 members	695			45	662			43
Number of kin relations (range 0–39)		8.5	5.4			8.9	6.0	
Proportion of kin relations								
< 60%	792			51	747			48
≥ 60%	760			49	805			52
Number of friends (range 0–20)		1.7	2.6			1.3	2.3	
0	765			49	892			58
≥ 1	787			51	660			42
Number of neighbors (range 0–14)		1.7	1.9			1.7	2.1	
Proportion neighbors								
< 11 %	751			48	774			50
≥ 11 %	801			52	778			50
Number of other non-kin (range 0–37)		2.9	3.1			2.9	3.2	

Note. T1 = Time 1; T3 = Time 3; MMSE = Mini Metal State Examination.

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the number of family members increased (mean difference 0.42, $p < .01$), the number of friends decreased (mean difference –0.44, $p < .01$), and the number of neighbors remained stable (mean difference –0.01).

The four types of network provided an adequate and parsimonious description of the data (time-homogeneous measurement model: $L^2 = 870$, $df = 540$, estimated expected proportion of classification error [E] = .18, reduction in the proportion of classification errors if the model is used [λ] = .76, two empty latent groups). A model with five types of network: (with $5^2 = 25$ possible transitions) resulted in 11 empty latent groups. A model with three types of network reduced the latent dimension by 7 (4^2–3^2), which exceeded the number of empty groups in a four latent-category variable. We therefore specified four types of network. Constraining the model to be time-homogeneous deteriorated the fit of the model at the $\alpha = .05$ level, but not at the $\alpha = .01$ level (log-likelihood ratio $L2 = 34.5$, $df = 20$, $p = .02$).

The first full model we tested was the saturated model, which included all higher order effects of age and of cognitive and physical decline (full model: $L^2 = 2612$, $df = 4554$). We subsequently removed nonsignificant effects. The three-way interaction effect of age, physical decline, and cognitive decline could be removed without deteriorating the fit of the model (L^2 ratio = 13.1, $df = 13$, $p = 0.44$). After that, all two-way interactions of age and of physical and cognitive decline were removed, without any adverse effect (L^2 ratio = 61.9, $df = 76$, $p = .89$). None of the direct effects of age or physical and cognitive decline on the probability of a change of network type from T1 to T3 could be removed without deteriorating the fit ($\alpha = .05$) of the model (removing the effect of age: L^2 ratio = 22, $df = 3$, $p < .01$; removing physical decline: L^2 ratio = 8.6, $df = 3$, $p = .04$; removing the effect of cognitive decline: L^2 ratio = 24.0, $df = 3$, $p < .01$). This indicated significant main effects of age and of physical and cognitive decline on the transition from a T1-type network to a T3-type network. The model we used in the analysis is presented in Figure 1. This model fit the data well ($L^2 = 2640$, $df = 4465$, $p = 1.00$, $E = 0.20$, $\lambda = 0.75$).

Network characterization

Based on the conditional probabilities, we can characterize the network types (see Table 2). The conditional probabilities within one indicator sum up to 1.00. Type I is characterized by a large network: 72% of the respondents within this type have more than 14 network members. All have a lower-than-average proportion of kin relationships (100%), 74% have at least one friend, and 62% have more than the mean number of neighbors in their network. A small to medium-sized network is characteristic of Type II. Adults with this type of network have fewer than the mean number of family members in their network, half of them have no friends, and about half (46%) have fewer than the mean number of relationships with neighbors. Type III is also characterized by a small to medium-sized network, but, in contrast to Type II, the network consists of more family members than average, and most Type II respondents have no friends and few neighbors. Type IV is similar to Type I in size, but in contrast to Type I, the network predominantly consists of kin relations. As stated earlier, other nonfamily relationships were omitted from the analysis because of their linear dependency on the other network indicators. However, because it might be of interest to know how the other relationships were distributed among the different types of networks, we performed an additional analysis on the mean number of other relationships in

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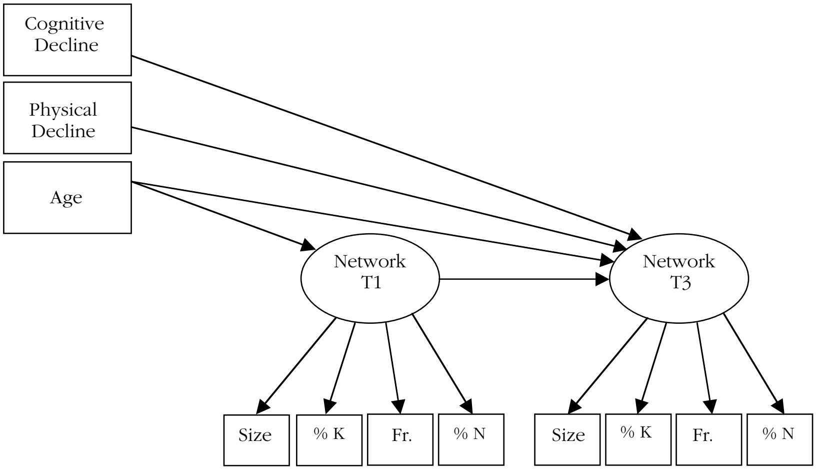
FIGURE 1
Full model with external variables age, cognitive decline, and physical decline. Indicator variables network size (Size), proportion kin (% K), friends (Fr.), and proportion neighbors (%N) in the network are shown in square boxes. Latent variables type of network at T1 and type of network at T3 are enclosed by ellipses.



the network. It appeared that, on average, 5.0 other members were included in a Type I network (*SD* = 4.39) and there were 2.0 in a Type II network (*SD* = 1.97). In a Type III network, there was a mean of 0.4 other members (*SD* = .78) and, in a Type IV network, there were 1.9 (*SD* = 2.19).

The latent class probabilities provide information about the frequency of specific network types (see Table 3). At T1, 32% of the respondents had a Type I network, 20% a Type II network, 16% a Type III network, and consequently 32% a Type IV network. At T3, the number of respondents with a Type I, Type II, or Type IV network decreased ($\hat{n}$s = 33.22, 32.43, and 28.56, respectively), and the number with a Type III network increased ($\hat{n}$ = 94.21).

The proportion of respondents who had the same kind of network at T1 and at T3 are presented in the diagonal cells. The sum of these proportions (0.70) indicates a great deal of stability in types of relationships over the six years of investigation (although not necessarily with the same persons). Stability varied across the T1 network types (χ^2 (3, N = 1552) = 13.8, p < .01), but the most stable was Type III, where it was estimated that 196.2 (78%) of the 250.8 respondents continued in this network type. Less stable were Type I (71%), and Type IV (67%). Type II was the least stable (62%).

We now consider the conditional probabilities of making a transition from one type of network to another, and the extent to which the likelihood of making a transition is associated with age or with physical or cognitive decline. First, we discuss differences in network stability, and then differences in the likelihood of changing to another kind of network, based on age and on physical and cognitive decline.

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TABLE 2
Conditional probabilities for the four network types at T1

	Network types			
Manifest variables	**Type I**	**Type II**	**Type III**	**Type IV**
Network size				
1–5	.00	.31	.45	.00
6–14	.27	.67	.46	.39
>14	.73	.02	.09	.61
% Kin relations				
< 60%	1.00	.87	.07	.04
≥ 60%	.00	.13	.93	.96
Friends				
0	.26	.57	.93	.53
≥ 1	.74	.43	.07	.47
% Neighbors				
< 11%	.38	.46	.79	.68
≥ 11%	.62	.54	.21	.32

Note. The model is assumed to be time-homogeneous, which means that conditional probabilities are the same at T3.

TABLE 3
Cross-tabulation of latent class probabilities at T1 and T3 (*N* = 1552)

	T3 (1998–1999)				
T1 (1992–1993)	**Type I**	**Type II**	**Type III**	**Type IV**	**Total**
Type I	.23 (350.0)	.01 (14.9)	.00 (3.6)	.08 (124.5)	.32 (492.9)
Type II	.01 (9.2)	.12 (190.7)	.06 (98.4)	.01 (7.8)	.20 (306.1)
Type III	.01 (10.4)	.03 (39.1)	.13 (196.2)	.00 (5.1)	.16 (250.8)
Type IV	.06 (90.2)	.02 (28.9)	.03 (46.9)	.22 (336.6)	.32 (502.5)
Total	.30 (459.7)	.18 (273.6)	.22 (345.0)	.31 (474.0)	1.00 (1552.3)

Note. Estimated absolute numbers are shown in parentheses.

External effects on network stability

Only significant transitional probabilities are presented in Table 4. The first row presents the likelihood of a transition from Type I at T1 to one of the four network types at T3 for young-old adults who experienced no decline in physical or cognitive functioning during that time. All probabilities within one row sum up to 1.00 and can be compared to the probabilities in the other seven categories. Greater age, a decline in physical functioning, and a decline in cognitive functioning contributed to a decrease in the stability of the Type I network. For example, young-old adults with no decline in cognitive and physical functioning (first row) had a probability of .79 of staying in a Type I network. For young-old adults who experienced a decline in cognitive functioning, the

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TABLE 4
Transitional probabilities among the four types of networks between T1 and T3, by age and changes in physical and cognitive functioning

				T3			
Type T1	**Age**	**Physical functioning**	**Cognitive functioning**	**Type I**	**Type II**	**Type III**	**Type IV**
I	55–75	No decline	No decline	.79 (.04)	–	–	.20 (.04)
			Decline	.72 (.06)	–	–	.25 (.06)
		Decline	No decline	.67 (.07)	–	–	.32 (.07)
			Decline	.59 (.09)	–	–	.38 (.09)
	75–85	No decline	No decline	.65 (.06)	–	–	.28 (.05)
			Decline	.51 (.09)	–	–	.30 (.08)
		Decline	No decline	.52 (.08)	–	–	.41 (.07)
			Decline	.39 (.09)	–	–	.43 (.11)
II	55–75	No decline	No decline	–	.68 (.08)	.22 (.06)	–
			Decline	–	.50 (.10)	.47 (.10)	–
		Decline	No decline	–	.63 (.09)	.27 (.08)	–
			Decline	–	.44 (.11)	.52 (.12)	–
	75–85	No decline	No decline	–	.69 (.08)	.30 (.07)	–
			Decline	–	.45 (.09)	.54 (.09)	–
		Decline	No decline	–	.64 (.09)	.35 (.08)	–
			Decline	–	.39 (.10)	.60 (.10)	–
III	55–75	No decline	No decline	–	.19 (.06)	.69 (.08)	–
			Decline	–	–	.89 (.05)	–
		Decline	No decline	–	.16 (.07)	.73 (.10)	–
			Decline	–	–	.91 (.05)	–
	75–85	No decline	No decline	–	.18 (.07)	.81 (.07)	–
			Decline	–	–	.93 (.04)	–
		Decline	No decline	–	.14 (.07)	.84 (.07)	–
			Decline	–	–	.94 (.04)	–
IV	55–75	No decline	No decline	.25 (.05)	–	–	.71 (.05)
			Decline	.18 (.06)	–	–	.69 (.08)
		Decline	No decline	.16 (.05)	–	–	.81 (.06)
			Decline	.11 (.05)	–	–	.78 (.09)
	75–85	No decline	No decline	.13 (.05)	.11 (.04)	.11 (.05)	.64 (.07)
			Decline	–	.15 (.06)	.40 (.10)	.39 (.09)
		Decline	No decline	.08 (.04)	.08 (.04)	.10 (.05)	.73 (.07)
			Decline	–	.11 (.05)	.38 (.10)	.47 (.11)

Note. Standard errors are shown in parentheses. Nonsignificant parameters are not shown.

likelihood of staying in Type I network decreased by .07. When there was physical decline, the decrease in likelihood was .12. The joint effect of cognitive and physical decline is equal to the sum of the effects of cognitive and physical decline alone (.19), suggesting that the effects of physical and cognitive decline on the probability of a change in one's network are additive.

An increase in age reduced the likelihood of maintaining a Type I network, so older-old adults were less likely than young-old adults to maintain a Type I network (decrease in likelihood was .14), even when they experienced no

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decline in cognitive and physical functioning. In sum, young-old adults with no decline in cognitive and physical capacity were twice (.79 vs. .39) as likely to have a Type I network at T1 and T3. The stability of Type II networks was lower when there was cognitive (–.17) and physical (–.05) decline, but it was almost completely unrelated to age (–.02). Type III networks were very stable both at higher ages and when cognitive and physical functioning decreased. Cognitive decline enhanced the stability of the Type III network among young-old adults by .20, whereas physical decline had only a small effect (.04) on stability. Type IV networks were most stable among young-old adults who experienced a decline in physical functioning (.81). The difference in stability between young-old and older-old adults was not very large in Type IV networks (.07), indicating a minimal age effect on network stability. Cognitive decline, however, reduced the stability of the Type IV network for older-old adults by .25. In contrast, physical decline enhanced network stability by .10.

Transitions between T1-type networks and T3-type networks

There are 12 possible transitions from one type of network at T1 to another at T3. Six of these were frequently observed: Type I to Type IV ($\hat{n} = 124.5$), Type II to Type III ($\hat{n} = 98.4$), Type II to Type IV ($\hat{n} = 49.4$), Type III to Type II ($\hat{n} = 39.1$), Type IV to Type I ($\hat{n} = 90.2$), and Type IV to Type III ($\hat{n} = 46.9$).

1. In changing from Type I to Type IV, friends and neighbors within a large network are replaced by family members. Greater age increased the likelihood of this happening (.08); cognitive decline increased the likelihood by .05 for young-old adults and .02 for older-old adults. Physical decline increased the likelihood by .12 for young-old adults and .13 for older-old adults.
2. A transition from Type II to Type III reflects a loss of network members – friends and neighbors. Cognitive decline and greater age increased the likelihood of a change from a Type II to Type III network; cognitive decline by a factor of .25 and increased age by .07. This transition was associated least with physical decline (.05). In other words, adults with a small to medium-sized network are likely to lose friends and neighbors if they experience a decline in cognitive functioning. Size seems to decrease as well – lost relationships are not likely to be replaced.
3. A transition from Type III to Type II, suggesting an increase of friends and neighbors in the network, was not observed when there was a decline in cognitive functioning. Physical decline and greater age showed only small effects (–.03 and –.01, respectively) on this sort of transition.
4. Young-old adults who have experienced no physical or cognitive decline had a greater likelihood of changing from a Type IV to a Type I network, reflecting an increase of friends and neighbors. Greater age reduced this likelihood by .12. The likelihood of making this change was reduced in the presence of physical decline by a factor of .09 for young-old adults and .05 for older-old adults. Cognitive decline reduces the likelihood by .07 for both young-old adults and older-old adults. In other words, older-old adults with a large network are unlikely to add new friends or neighbors to their network under any circumstances.
5. A change from Type IV to Type II implies an increase in the number of neighbors in one's network, but a net loss in the total number of relationships, mainly due to the loss of family members. This type of transition was

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observed only among older-old adults and was increased by .03 in the case of cognitive decline. Physical decline, in contrast, decreased the probability of this kind of transition (–.03). However, these effects were rather small and this type of transition was not often observed.

6. In a transition from a Type IV to Type III network, there is a net loss of members, due to the loss of friends and neighbors. As seen in the transition from Type IV to Type II networks, this transition was observed only among older-old adults. Older-old adults with a large network were most likely to lose friends and neighbors when there was a decline in cognitive functioning, which results in a decrease of the network size. Physical decline, however, did not increase the probability of losing friends or neighbors.

Hypotheses

In stating Hypothesis 1, we posited that, based partly on the size of the network, greater age and a decline in cognitive and physical capacity would increase the probability of neighbors being replaced by relatives and friends in an individual's network. What we found was that people with a large network tended to replace neighbors with family members in cases of physical decline; however, this did not occur if the network was small. Greater age was associated with the replacement of nonrelatives by family members when the network was large, but in smaller networks, no such association existed. Cognitive decline, however, led to the replacement of neighbors and friends with family only when the network was small. Contrary to our expectations, a decline in physical and cognitive functioning was also associated with a decline in the proportion of friends in the network.

With respect to the second hypothesis, which stated that cognitive and physical decline would mobilize helpers and would therefore not result in a decline in the size of the network, we found that physical decline led to the mobilization of helpers only when the network was large, and cognitive decline led to the mobilization of helpers only when the network was small. Therefore, the second hypothesis was partly confirmed by our results.

Discussion

We studied the effects of age and of cognitive and physical decline on network size and composition in a sample of older Dutch adults over a six-year period. Cognitive decline was observed for about 21% of the adults, 20% experienced physical decline, and about 7% suffered from both cognitive and physical decline.

We hypothesized that, because of age and cognitive and physical decline, an individual's personal network would increasingly consist of family members (Hypothesis 1) and that replacements of friends and neighbors in the network by family members would not affect the size of the network (Hypothesis 2). Four network types were distinguished, based upon differences in size and composition. Over time, transitions from one network type to another were observed for 31% of the study sample. What we found was that adults with a large network replaced neighbors and friends with family members in cases of physical decline, but not when the network was

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small. Greater age was associated with replacement of neighbors and friends with family when the network was large, but not when the network was small. However, cognitive decline was associated with the replacement of neighbors and friends with family only when the network was small. Contrary to our expectations, a decline in physical and cognitive functioning was also associated with a decline in the proportion of friends. We further observed that physical decline led to a mobilization of helpers only when the network was large, and that cognitive decline led to a mobilization of helpers only when the network was small.

Our findings that the personal network increasingly consists of kin support the prediction based on Socio-emotional Selectivity Theory (SST; Carstensen, 1992). However, our study did not provide evidence for an increasing number of friends (rather than neighbors), which is also predicted by SST. This finding could be explained by the fact that we did not distinguish between close friends and other kinds of acquaintances. According to the process of Selective Optimization with Compensation (SOC; Baltes & Carstensen, 1996), individuals who face a decline in physical or cognitive capacity actively adapt their personal network to meet their increasing need for support. We observed that indeed, in large networks, physical decline is related to the replacement of neighbors and friends with family members, suggesting an increase in the number of potential long-term helpers. Cognitive decline, too, is related to the replacement of neighbors and friends with family members but only in small networks. Apart from the influence of the size of the network, our results seem to be in line with the theory. As kin relationships are most likely to provide long-term support (Litwak, 1985), an increase in the support received is to be expected. However, we did not include measures of support received as indicators of network type, so this could not be tested in the present study.

Two findings are still unexplained. First, it appeared that, contrary to those with a large network, individuals who had a small network at baseline and who suffered from physical decline did not have an increased likelihood of replacing friends and neighbors with family members. Assuming that all individuals try to maximize support when their need for care increases, the size of the network also seems to be a determinant of the amount of support exchanged. Members of a small network appear to be more willing to supply support than members in a large network. This is supported by Coleman (1990), who suggests that members of a small network are inclined to give support, even when the balance of receiving and providing is affected, whereas members of a large network are inclined to minimize their investments in relationships and maximize the profits. This 'profiting' behavior, also called free-rider activity, is less likely in small groups. Coleman suggests that close networks, in which persons are mutually related to each other, facilitate the creation of norms and sanctioning systems, which can overcome free-rider activity and transform it into zeal, with the result that people are willing to contribute to the well-being of the members of their network.

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Another finding that does not follow directly from the theory is that older-old adults (those aged between 71 and 85 years at the beginning of the study) who faced a decline in cognition lost kin relationships from the network. It seems that, even within the family, a relationship in which one person becomes cognitively impaired is more difficult to maintain than a relationship in which one becomes physically impaired. Further research into the flow of support in unbalanced relationships is needed to address this problem. As yet, we are unable to decide to what extent compositional changes can be attributed to the focal person of the network, or to its members. To say anything more about this, one must consider the motives, decisions, and behavior of nearly all the members of the network, but no information of this sort has been collected in the LASA.

In the present study, no attempt was made to include other factors that might be related to the transitional probabilities between the types of networks. For example, we did not consider the effect of gender. Men and women may differ in duration of relationships, or in their preference for specific relationship types. However, inclusion of more factors in the model would increase the complexity of the outcomes, as each dichotomous predictor variable doubles the number of parameters to be estimated.

The log-linear path model with latent variables appears to have been appropriate for studying the effects of cognitive and physical decline on the composition of the network. This type of modeling enabled us to focus on types of networks rather than considering network characteristics separately. Furthermore, the inclusion of external variables allowed us to make judgments about the influence of age and of physical and cognitive decline on changes in the composition of the network. However, there are also some disadvantages. First, although not indicated by the fit of the model, the idea that all types of networks can be reduced to only four may stretch the truth. Also, dichotomizing the network characteristics masked the variability in our data set.

To conclude, the findings of our study suggest that cognitive functioning is an important condition for social integration and thus for the well-being of older individuals. A decline in cognitive functioning may disrupt the balance of support received and provided, resulting in the end of the relationship. A decline in cognitive functioning thus leads to the loss of potential sources of support, and older adults are thrown more and more on their own family for support. Given the decrease in birthrates and the fact that informal care is provided mostly by daughters (Broese van Groenou & Knipscheer, 1999), and given the increasing participation of women in the workforce, there may not be sufficient informal care for older adults suffering from cognitive decline in the future. If support from children or family members is not complemented by other members of the network, older adults will become more and more dependent upon formal care, and it is not clear whether institutions providing formal care are being prepared sufficiently to meet this increasing demand.

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